municated to the Berlin Academy of Sciences in May, 1899. This memoir, which seems to be monumental in character, is remarkable in that it verifies the Stefan-Boltzmann law, derived from thermodynamic considerations, that the total energy radiant from a black body is proportional to the fourth power of the absolute temperature, and the law of W. Wien concerning the distribution of energy in the spectrum of a black body.

Wien's conclusions are based upon certain assumptions as to the number of radiant centers (molecules) in unit volume and their velocity. It is now known that the total energy radiated from a black body and its distribution in the spectrum depend only upon temperature and are entirely independent of the physical properties of particular substances, so that it is highly probable that the law of total energy and the law of its distribution in the spectrum are capable of rigorous derivation from assumptions of axiomatic simplicity.

The theoretical results of Stefan, Boltzmann and Wien, now verified by Planck, may, therefore, eventually appear to be independent of the highly specialized character of the assumptions upon which they are based. When this stage of the science is reached, these laws of radiation will no longer appeal to experiment for verification, but they will take their place among numerous other established laws as instruments for the interpretation of experimental results.

Physicists ought to drop the term radiant energy and retain the older and better term radiant heat, inasmuch as the energy of radiation is heat in the same sense that molecular energy is heat. Both types of energy are subject to the first and second laws of thermodynamics; both types give rise to the entropy function, and Maxwell's law of molecular velocity distribution is strictly analogous to Wien's law of the distribution of energy in the spectrum.

THERMAL CONDUCTIVITY.

HEAT measurements are among the most inaccurate of physical measurements and the measurement of thermal conductivity is perhaps the most inaccurate of the measurements in heat. Professor Kohlrausch (*Drude's Annalen*, January, 1900) proposes a method for measuring thermal conductivity which depends upon the final permanent distribution of temperature in a conductor carrying electric current, heat being allowed to flow out of the conductor only at the points where current enters and leaves it. Under these conditions a remarkably simple relation subsists between the temperature at a point, the electric potential at a point, and the ratio of electrical to thermal conductivity. The method depends only upon measurements of temperature, of electrical potential, and of electrical conductivity. W. S. F.

ENGINEERING NOTES.

A NUMBER of European nations are now adopting the Gruson chilled iron shield for their land defences and the success of the invention is so well-assured, it is said, that the Messrs. Krupp, some time since, bought the *Grusonwerke* and have developed the invention to a state of considerable perfection. The Gruson armor-turrets are thought to be practically invulnerable; their flatly curved tops deflecting shot and shell and their adamantine chilled surfaces and their great thickness making them impenetrable to direct impact of the heaviest shot. It is proposed to endeavor to introduce this device into the United States, where it is thought that it may be made even more successful, since our chilling irons are found to be superior to those of any other country. The turrets are usually of from 50 to 100 tons weight and are built up of great staves and segments, ten or fifteen of which constitute the low, wide, circular, covered box which constitutes the turret and protects the guns. The top is usually made of two semi-circular halves. In their manufacture, the quality of iron employed is presumably that found to make the best car wheels and one of peculiar strength and toughness, as well as of intensely hard chilling property. A *Grusonwork* is to be established at Chester, Pa., by New York and Philadelphia capitalists.

THE success of the submarine craft which have been recently produced in the United States and in France is stimulating other nations, and an authority among English technical journals—*Industries and Iron*—says: "In spite of the derision with which they have been

received by our Admiralty, there is a prospect of submarine torpedo boats, becoming an important factor in the future strategy of marine warfare. Apart from the ancient history of diving or submarine torpedo boats, the recent activity, notably of the French and American naval authorities, and the favorable views with which the experts of these two nations look upon the latest developments in submarine torpedo boats, is more than ample justification for our Admiralty giving serious consideration to this most dangerous and constantly improving mode of torpedo attack. Our battleships are estimated to be worth £40,000,000 and our protected cruisers about £26,000,000, whilst other fighting ships of our Navy are valued at about £34,000,000, making in all a grand total of £100,000,000. Surely if our costly Navy is to be menaced with such a system of deadly torpedo attacks as may reasonably be anticipated from the modern submarine boats of foreign naval Powers, it behooves our Government to test and adopt counteracting means of attack, and also to endeavor to secure some more reliable means of defence against such attacks than at present obtain in our Navy."

THE last year was the 'record year' for Great Britain as well as for the United States. That country registered a foreign trade totaling about four thousand dollars. The imports were £485,000,000, of £12 per capita of total population, the exports £264,000,000, about £6 // 11s, per capita and the re-exports £65, averaging £1 // 12s. There has never been a year in which so much trade was reported, so much manufacturing done or so much profit secured; notwithstanding the enormous amount of successful competition in the British market and the markets of the world, to which the United States and Germany have attained. Prosperity has been quite extraordinary in all manufacturing and exporting countries.

R. H. T.

BOTANICAL NOTES.

BOTANY AT WOODS HOLL.

FOR about a dozen years opportunities for botanical study have been offered to botanists at the Marine Biological Laboratory at Woods Holl, a seaside town on the southern coast of Massachusetts. Year by year the work offered has been enlarged, so that now, under the direction of Dr. B. M. Davis, of the University of Chicago, it includes a laboratory study of algæ, fungi, plant physiology, plant cytology and micro-technique, with lectures covering nearly the whole field of botany. The laboratories are open from July 5th to August 16th.

When we think of the poor preparation of so many of our teachers of botany in the high schools, and even the colleges and the so-called universities, it is strange that more of them do not take advantage of the opportunities offered by such a school as this at Woods Holl. It is encouraging to see that already eighteen colleges are coöperating in supporting this laboratory school. There should be many more of these. Every large institution should offer as a prize to its advanced men a room or table in the Woods Holl Laboratory. In many cases this would be of much more value to the recipient than a scholarship or fellowship costing the institution much more money. These might be called 'Woods Holl Scholarships,' the recipient to spend the season in work in the laboratory, and to bring back into his college at the end of the summer vacation the results of his studies.

MINNESOTA BOTANICAL STUDIES.

THE thick 'part' of this interesting and unique publication which appeared early in January, contains articles on *Chlorochytrium* (an endophytic alga of the Protococcaceae, found in the thallus of a marine seaweed), *Rhodymenia* (a red seaweed from the Pacific Coast), the Lichens of the Lake Superior Region (enumerating one hundred and fifty-eight species and varieties, forty-six of which had not hitherto been recorded from the interior flora of the United States), Lichens of the Minnesota Valley (enumerating two hundred and one species and varieties of which forty-one had not hitherto been recorded from Minnesota, one being new to science), Synonymic Conspectus of Native and Garden Aquilegias of North America (describing forty-six species and varieties), Synonymic Conspectus of the Native and Garden Aconitums of North America (describing seventeen species and varieties).